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(54) **Conjugate filamentary yarns.**

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Description

Background of the invention

The present invention relates to conjugate filamentary yarns consisting of thermoplastic elastomer and non-elastomeric polyamide or polyester, wherein the structural arrangement of the conjugate components makes both their respective stretchability resulting from fine crimp and elasticity of elastomer itself available for obtaining conjugate filamentary yarn.

Description of the prior art

It has hitherto been generally known that conjugate filamentary yarns prepared by conjugating two polymers having dissimilar heat shrinkage characteristics in a side-by-side or eccentric sheath-core arrangement have latent crimpability. Of them all, those conjugate filamentary yarns which are composed of elastomeric polyurethane elastomer as one component and non-elastomeric polyamide as the other component (disclosed in the specification of US Patent No. 4106313 and in the gazette of Japanese Patent Publication No. 27175/80) are used in textile products where crimpability is required, such as panty hose and the like, because of their excellent stretchability arising from their fine and numerous crimps. These conjugate filamentary yarns prepared by use of polyurethane elastomer are advantageous in that polyurethane elastomer helps the yarns to form fine crimps making the best use of its high heat-shrinkability. However, its property of elasticity (rubber-like elasticity) is scarcely utilized.

On the other hand, polyurethane filamentary yarn has such a high elongation as 400 to 500% when measured in terms of rubber-like extension. It is difficult to use a yarn of such high elasticity, and therefore it is necessary to control its high elongation to 200 to 300%. As the method to achieve this object, a so-called covered yarn, which is prepared by winding a crimped yarn or flat yarn around the urethane elastic yarn singly or doubly, is used. However, a covered yarn of this type is practically useful only for special purposes, because of its high cost arising from the fact that the urethane elastic yarn is obtained by the wet spinning method or the dry spinning method, which is less productive than the melt spinning method, and also the covering process adds to its cost. Also such covered yarn has a demerit in that it lacks the bulkiness inherent in a crimped yarn.

British patent No. GB—A—1 518 500 (Courtaulds) discloses bicomponent filaments comprising a first component which is a polyamide and a second component which is an elastomeric polyurethane. The filaments are characterised by the composition and properties of the polyurethane.

Summary of the invention

An object of the present invention is to provide a crimped stretch yarn having the property of rubber-like elasticity inherent in an elastomer in addition to the crimp bulkiness and stretchability produced by conjugating an elastomeric thermoplastic elastomer and a non-elastomeric polyamide or polyester in a specific conjugate arrangement.

Therefore the present invention provides a conjugate filamentary yarn in which each of the individual filaments comprises an elastomeric thermoplastic polymer component and a non-elastomeric thermoplastic polymer component in side-by-side or eccentric sheath-core relationship, characterised in that, the non-elastomeric thermoplastic polymer component is a polyamide or a polyester, each of the individual filaments has an elongate cross section, and the respective components are arranged in such a way as to satisfy formulae (I) to (III) simultaneously:

$$4 \geqq \frac{b}{a} \geqq 1.2 \qquad \text{(I)}$$

$$2.3 \geqq \frac{EA}{PA} \geqq 0.43 \qquad \text{(II)}$$

$$\overline{EiPi} \geqq \frac{a}{2} \qquad \text{(III)}$$

where a indicates the length of the minor axis which passes the centre of gravity on the cross section of the filament; b, the length of the major axis which passes the centre of gravity on the cross section of the filament; EA, the area occupied by elastomer on the cross section of the filament; PA, the area occupied by non-elastomeric polyamide or polyester on the cross section of the filament; and $\overline{EiPi}$, the distance between the centre of gravity Ei of the elastomer component on the cross section of the filament and the centre of gravity Pi of the non-elastomeric polyamide or polyester component respectively.

Brief description of the drawings

Fig. 1 illustrates typical cross sections of the filaments of the present invention, Fig. 2 shows cross

sections of conventional conjugate filaments, Fig. 3 represents a series of lateral views of a short segment of the filaments of the present invention to show its physical behavior at different degrees of stretch, Fig. 4 represents similar lateral view of the conventional conjugate filaments, and Fig. 5 is rough sketches of the spinnerets used for spinning conjugate filaments of this invention.

Description of the preferred embodiments

The inventors of the present invention have conducted an intensive and extensive study on conjugate stretch yarns comprising thermoplastic elastomer and non-elastomeric polyamide or polyester in search of a structure of the conjugate stretch yarn in which stretchability resulting from crimp and rubber-like elasticity arising from elastomer are in the best structural combination to produce the highest degree of stretchability. The study has resulted in the finding of the fact that the structure of the conjugate stretch yarn becomes most desirable when the filament has an elongate cross-section, for instance figure-8-shaped or oval, in which the two components are conjugated together in such a way as to have their respective centres of gravity on the major axis.

The present invention will be explained in detail referring to the accompanying drawings. In Figs. 1 to 4, i indicates the centre of gravity on the cross section of the filament; a, the length of the minor axis which passes the centre of gravity i on the cross section of the filament; b, the length of the major axis which passes the centre of gravity i on the cross section of the filament; E, the elastomer component; P, the non-elastomeric polyamide or polyester component; Ei, the centre of gravity of the elastomer component on the cross section of the filament; and Pi, the centre of gravity of the polyamide or polyester component on the cross section of the filament respectively.

The filaments proposed in the present invention have an elongate cross-section, for instance figure-8-shaped or oval, in their cross section as shown in Fig. 1, (a), (b), or (c). In setting up such form, the filament has two components conjugated to each other, i.e., a component E comprising thermoplastic elastomer and a component P comprising non-elastomeric polyamide or polyester, each having its centre of gravity located on the major axis on its cross section. In other words, the two components are structurally conjugated together to hold the minor axis in common as their contact surface. When such a filament is made to develop crimp, it takes the form of a three-dimensional spiral crimp with the component E located inside the spiral and the component P outside the spiral as shown in Fig. 3, (a). As the filament is stretched, the component E is stretched straight, while the component P takes the form of a helical thread of a wood screw and surrounds the component E forming a certain angle and accordingly the filament itself exhibits the structure of a screw as shown in Fig. 3, (b). The exhibition of such a structure is attributable to a fact that the centre of gravity Ei of the elastomer component is remote from the centre of gravity i on the cross section of the filament on the major axis and the component E can shrink much more than the component P because the component E has a greater value in terms of the physical construction of elasticity as well as heat-shrinkage greater than the component P.

When the filament exhibiting the structure of a screw is further stretched, it can be stretched as far as it takes the form shown by Fig. 3, (c).

Therefore, it may be said that at the stage in which the state of the filament shown in Fig. 3, (a), shifts to the state of Fig. 3, (b), the crimp stretchability is dominant; while at the stage in which the state of the filament shown in Fig. 3, (b) shifts to the state of Fig. 3, (c), the rubber-like elasticity is dominant.

The addition of this rubber-like elastic property to the conjugate filamentary yarn is a most remarkable characteristic of the present invention and this property can never be made available for conventional conjugate filamentary yarns in which each of the individual constituents presents a circular cross-section like those shown in Fig. 2, (a) and (b).

A conjugate stretch filament which has a cross section as shown in Fig. 2, (a) and (b) varies its shape in the order of Fig. 4, (a), (b), and (c) as the degree of stretch increases. A stretch filament of this type has the form of a three-dimensional spiral crimp with the component E located inside the spiral and the component P outside the spiral as shown in Fig. 4, (a), quite similar to the one shown in Fig. 3, (a).

When this crimped stretch filament is stretched, it directly takes the form shown in Fig. 4, (b), without taking the form of a screw which can be realized by the conjugate stretch filament of the present invention in Fig. 3, (b). Therefore, the filament can simply make use of crimp stretchability which is dominant only at the stage in which the state of the filament shown in Fig. 4, (a) shifts to the state of Fig. 4, (b). The filament accordingly can make no use of rubber-like elasticity which arises from its screw structure occurring at the stage in which the state of the filament shown in Fig. 4, (a), shifts to the state of Fig. 4, (c), in stepwise stretching.

Therefore, the crimped stretch yarn of high stretchability which can make the most of both stretchability arising from crimp and rubber-like elasticity resulting from elastomer should necessarily be a conjugate filamentary yarn in which each of the individual constituents takes the form of the screw structure shown in Fig. 3, (b).

It is essential for a conjugate filament which takes the form of the screw structure to simultaneously satisfy both relationships of

$$\frac{b}{a} \geq 1.2 \quad \text{and} \quad \overline{EiPi} \geq \frac{a}{2},$$

where a indicates the length of the minor axis which passes the centre of gravity i on the cross section of the filament; b, the length of the major axis which passes the centre of gravity i on the cross section of the filament; and $\overline{EiPi}$, the distance between the centre of gravity Ei of the elastomer component on the cross section of the filament and the centre of gravity Pi of the non-elastomeric polyamide or polyester component respectively. When the centre of gravity Ei of the elastomer component shifts too close to the centre of gravity i on the cross section of the filament and results in

$$\frac{b}{a} < 1.2 \quad \text{and} \quad \overline{EiPi} < \frac{a}{2},$$

the shrinking point of component E comprising the elastomer comes too close to the centre of gravity i on the cross section of the filament and accordingly enough shrinkage cannot be caused to make the filament form a screw structure.

It will be easily understood that the efficient making of such a screw structure like the above can be achieved more satisfactorily when the contact surface between the E component of elastomer and the P component of polyamide or polyester is made small and also when the centre of gravity Ei of the elastomer component is remote from the centre of gravity Pi of polyamide or polyester component and the centre of gravity i on the cross section of the filament as shown in Fig. 1, (a).

In the present invention it is essential for the filament to have the relation between a and b which satisfies the formula

$$4 \geqq \frac{b}{a} \geqq 1.2$$

in order to have said screw structure and the cross section of the conjugate filament to be satisfactorily useful as clothing materials. When

$$\frac{b}{a}$$

is larger than 4, the cross section of the filament becomes too flat and when it is woven or knitted into a fabric, the fabric has rough harshness which makes the hand or feel unsatisfactory. Also when the filament is crimped, the resulting crimp coils are too large to make fine crimp and accordingly the stretchability of the thus-obtained crimped stretch yarn is bad. On the other hand, when

$$\frac{b}{a}$$

is smaller than 1.2, the stretchability of the crimped filament is improved but the crimp filament cannot form a screw structure as mentioned before and the rubber-like elasticity cannot be utilized.

Furthermore, in the present invention it is necessary for the filament to have the relation between the area EA of component E on the cross section of the filament and the area PA of component P on the cross section of the filament which satisfies the formula

$$2.3 \geqq \frac{EA}{PA} \geqq 0.43.$$

When

$$\frac{EA}{PA}$$

is larger than 2.3, the elastomer component becomes too large and lowers the color fastness and degrades the physical properties such as strength, elastic stretchability, etc. of the obtained crimped stretch yarn and the woven or knitted fabrics prepared from such crimped stretch yarn are unfit for use. When

$$\frac{EA}{PA}$$

is smaller than 0.43, the rubber-like elasticity becomes extremely small and a crimped stretch yarn having

both crimp stretchability and rubber-like elasticity according to the present invention cannot be obtained. It is most desirable to keep the value of

$$\frac{EA}{PA}$$

in the range of 0.67 to 1.5, usually it is to be set at 1.

Next, it is necessary in the present invention to keep the distance $\overline{EiPi}$ beween Ei and Pi more than

$$\frac{a}{2}.$$

More particularly, it means that the centres of gravity Ei and Pi are substantially on the major axis b and that the distance $\overline{EiPi}$ between the two centres of gravity is more than

$$\frac{a}{2}$$

which makes the cross section of the filament elongate, such as figure-8-shaped or oval as shown in Fig. 1 and also locates the centres of gravity of the two components on the major axis. Conjugate filaments having such a circular cross section as shown in Fig. 2, (a) and (b) are not included in the range of claims laid by the present invention. When $\overline{EiPi}$ is smaller than

$$\frac{a}{2},$$

the stretchability arising from crimp may be developed fully but the aforementioned screw structure can not be obtained. The filament will simply take the form of a crimped filament of conventionally known three-dimensional spiral structure which can make use of its non-elastomeric polymer's property only but no use of rubber-like elasticity of its elastomer component.

It is desirable to have the centres of gravity Ei and Pi of the two components located on the major axis which passes the centre of gravity i. However, Ei and Pi may be located somewhat off the major axis. In this case, an angle between the minor axis which passes i and the straight line $\overline{iEi}$ connecting Ei and i or the straight line $\overline{iPi}$ connecting Pi and i should desirably be kept within the range of 90°±30°.

The conjugated structure of a filament which has such a cross section is effected by conjugating a component E comprising elastomer and a component P comprising non-elastomeric polyamide or polyester in a side-by-side or eccentric sheath-core arrangement.

As thermoplastic elastomer to be used to form the elastic component in the present invention, it is recommendable to use elastomer which is melt spinnable, having a hardness of 90 to 100 when determined according to JIS K-6301. This type of thermoplastic elastomer includes elastomer of polyurethane type and elastomer of polyamide type. The former elastomer of polyurethane type is thermoplastic polyurethane which is obtained by reacting a mixture which consists essentially of polyester having a terminal hydroxyl group and/or poly(oxyalkylene) glycol having a molecular weight of 1000 to 3000, diisocyanate, and glycol as chain-extending agent, and further addition of polycarbonate having a terminal hydroxyl group as may be required. As the polyester mentioned above, dibasic acids such as sebacic acid and adipic acid, and diols such as ethylene glycol, butylene glycol and diethylene glycol, may be used. As the poly(oxyalkylene) glycol, such block copolymers or homogeneous polymers as poly(oxyethylene)glycol, poly(oxypropylene)glycol or poly(oxybutylene)glycol can be used. As diisocyanate, 2,4 - tolylenediisocyanate, diphenylmethane - 4,4' - diisocyanate, or dicyclohexyl methane - 4,4' - diisocyanate may be selected. As the chain-extending agent, ethylene glycol, propylene glycol, butylene glycol, or 1,4 - β - hydroxyethoxybenzene can be used. As polycarbonate to be used optionally, a polymer of either bisphenol A and phosgene or bisphenol A and diphenylcarbonate having a terminal hydroxyl group must be used.

As the latter elastomer of polyamide type, a copolymer of polylauryl lactam and dicarboxylic acid of polybutylene glycol (produced from 1,4-butanediol) is generally used. The hardness can be controlled by adjusting the molecular weight of butylene glycol which composes the rubber ingredient or also by changing the copolymerization ratio between polylauryl lactam and rubber ingredient. As polyester which is one of the non-elastomeric components, polyethylene terephthalate, polybutylene terephthalate or polypropylene terephthalate, which has generally the fiber-forming property may be mentioned, of which polyethylene terephthalate and polybutylene terephthalate may be counted as the desirable polyester. A copolymer prepared by copolymerizing 5-sodium sulfoisophthalic acid with any of these polyesters is more

desirable because it has good adhesion to elastomer. As polyamide, which is another of the non-elastomeric components, nylon 6, nylon 66, nylon 610, nylon 11, nylon 12 and nylon 13, may be mentioned and among them, nylon 6 is especially recommendable. In determining the combination of an elastomeric component and a non-elastomeric component, care should be exercised in their selection, taking good compatibility and conjugating adhesiveness of the respective components into consideration so that the conjugated two components will not separate from each other during the stage of melt spinning, drawing, texturing, weaving, and knitting. Especially in the case where polyester is used as a non-elastomeric component, it is recommendable to use elastomer of polyester type, for instance, a block copolymer of polyether and polyester as thermoplastic elastomer. Also it is desirable to use polyethylene terephthalate copolymerized with 5-sodium sulfoisophthalic acid as a polyester component since it improves the conjugating adhesiveness. On the other hand, in the case where polyamide is used as a non-elastomeric component, it is desirable to use polyurethane of caprolactone type or polycarbonate type, or elastomer of polyamide type, for instance, a copolymer of polylauryl lactam and polyol, as thermoplastic elastomer.

A resistance-to-light improving agent, such as a compound of benzophenone or benzotriazole or an inorganic manganese compound, may be added to elastomer and/or polyamide to improve their resistance to light.

By way of example, a method will be cited for obtaining the aforementioned crimped stretch yarn in which both stretchability arising from fine crimp and rubber-like elasticity of elastomer itself are utilized in a conjugate filamentary yarn, wherein the method comprises conjugate melt spinning thermoplastic elastomer and non-elastomeric polyamide or polyester in a side-by-side or eccentric sheath-core arrangement, followed by the processes of drawing, heat treatment, and relaxed heat set treatment.

As the spinneret for conjugate melt spinning a filamentary yarn in a side-by-side arrangement in the abovementioned method, a spinneret like the one shown in Fig. 5, (a), which is designed to separately extrude the component E consisting of elastomer and the component P consisting of non-elastomeric polyamide or polyester from the respective spinneret holes and conjugate the two components at a point immediately after their extrusion from the spinneret, is recommendable as a proper spinneret. Fig. 5, (a), is a sectional side view of such an example of a spinneret. The component E and component P are respectively led to the conduits A and B and extruded from the spinning holes HE and HP. At this time, the aforementioned a/b ratio can be set as required by adjusting the distance l between the spinning holes HE and HP and the angle θ formed by these two spinning holes. When l is made larger and θ is made smaller,

$$\frac{b}{a}$$

becomes larger. In contrast with this, when l is made smaller and θ is made larger,

$$\frac{b}{a}$$

becomes smaller. In order to satisfy the condition of

$$4 \geqq \frac{b}{a} \geqq 1.2$$

stipulated by the present invention, necessary adjustment can be obtained when l is within the range of 0.3 mm to 0.1 mm and θ is 8° to 30°.

Furthermore, EA and PA can be set as required by adjusting the extrusion rates of the component E and component P respectively by means of a gear pump (not shown in the drawing) on the spinning machine. The area of the spinning holes HE and HP may be designed to meet the desired extrusion rates respectively. To give some reasonable criterion, the condition of $2.3 \geqq EA/PA \geqq 0.43$ provided by the present invention can be satisfied when the linear velocity at the spinning hole is within the range of 5 m/min to 13 m/min.

The adjustment of $\overline{EiPi}$ varies depending upon the other two conditions; however, in the case where the spinning holes HE and HP are circular, when l is made larger, $\overline{EiPi}$ becomes larger and when θ is made smaller, $\overline{EiPi}$ also becomes larger as in the case of changing the conditions of

$$\frac{b}{a}$$

In another way, the adjustment of $\overline{EiPi}$ can also be effected by changing the shape of the spinning holes HE and HP. When HE and HP are made triangular and arranged at a distance l as shown in Figure 5, (b), $\overline{EiPi}$

becomes larger than when HE and HP are circular. Contrarily, when they are arranged as shown in Fig. 5, (c), $\overline{EiPi}$ becomes smaller.

What we have mentioned with regard to Fig. 5 in the above does not set any limitations on the present invention.

In the case where the filament is conjugate melt spun in an eccentric sheath-core arrangement, a spinneret described in the gazette of Japanese Patent Publication No. 27175/80 is suitable. The conjugate melt spinning in an eccentric sheath-core arrangement makes the elastomer component take its place in the core position and, therefore, is very effective in that it solves the problem of causing cohesion between the elastomer components at the time of take up which causes a difficulty in separating them into individual filaments as seen with the conjugate melt spinning of a filament in a side-by-side arrangement.

In order to make thus obtained conjugate yarn into a crimped stretch yarn in which both stretchability arising from fine crimp and elasticity of elastomer itself are to be utilized, the desired crimped stretch yarn can be easily obtained by subjecting the conjugate yarn to the drawing and heat treatment followed by relaxed heat set treatment conducted in a flow of heated fluid. It is desirable to make the crimped stretch yarn obtained after the relaxed heat set treatment show a shrinkage of 22% or less in boiling water treatment. When the crimped stretch yarn shows a shrinkage in excess of 22%, it tends to have inferior weavability and knittability and the fabric prepared therefrom shows unsatisfactory dimensional stability. The shrinkage in boiling water treatment tends to increase when the temperature of heat treatment after drawing is low or the temperature of the heated fluid is low; however, it is perfectly possible to make the shrinkage 22% or less in boiling water treatment when the treatment temperatures are kept within the range of heat treatment temperature after drawing and temperature of the heated fluid as mentioned hereunder.

It is desirable to keep the temperature of heat treatment after drawing in range of room temperature up to 120°C. When the temperature of said heat treatment is kept in excess of 120°C, the obtained crimped stretch yarn shows a shrinkage of 22% or less in boiling water treatment. This improves the dimensional stability but reduces the degree of stretchability, thus tending to prevent the development of the desired stretchability resulting from crimp. Incidentally, the drawing is desirably conducted at ordinary operation temperature ranging from room temperature to 60°C.

It is desirable to keep the temperature of the heated fluid ejected into the jet nozzle within the range of 80 to 150°C. When the temperature of the fluid is below 80°C, the shrinkage in boiling water treatment increases, which tends to be undesirable in terms of dimensional stability. On the contrary, when the temperature exceeds 150°C, the shrinkage decreases but it tends to increase the elongation at break, which leads to "tight pick" in a fabric and also to a lower degree of stretchability, making the desired stretchability unobtainable. As the fluid to be used in this treatment, both air and steam are recommendable; however, air is more recommendable since it makes less noise.

As the heated fluid nozzle, nozzles which have hitherto been used for relaxed heat set treatment, such as those disclosed in the gazette of Japanese Patent Publication No. 37576/70, gazette of Japanese Utility Model Publication No. 9535/71, and specification of U.S. Patent 4188691, can be used. A stretch yarn having fine uniform crimp can be obtained at high speed by use of a fluid stuffing nozzle of this type.

It is desirable to have a relaxation percentage of 10% or more as a result of the relaxed heat set treatment conducted by use of a heated fluid nozzle, more desirably between 10% and 40%. The reason is that the degree of stretchability varies greatly depending upon the relaxation percentage determined at the time of relaxed heat set treatment and therefore it is desirable to adjust the relaxation percentage within the abovementioned range in order to obtain a stretch yarn having the desired degree of stretchability (elastic stretchability). When the relaxation percentage obtained at this time is less than 10%, the degree of stretchability will be low and the resulting crimped stretch yarn will tend to the loss of desirable stretchability. The said relaxation percentage is determined by the following equation:

$$\text{Relaxation percentage (\%)} = \frac{\left(\begin{array}{c}\text{Running speed}\\ \text{of yarn before}\\ \text{passing heated}\\ \text{fluid nozzle}\end{array}\right) - \left(\begin{array}{c}\text{Running speed}\\ \text{of yarn after}\\ \text{passing heated}\\ \text{fluid nozzle}\end{array}\right)}{\left(\begin{array}{c}\text{Running speed of yarn before}\\ \text{passing heated fluid nozzle}\end{array}\right)} \times 100$$

As for the processes of drawing and heat treatment, any of the so-called separate drawing methods in which spinning and drawing are conducted in independent processes and the so-called spin-drawing methods in which spinning and drawing are conducted continuously can be followed. Also, the so-called DTY method in which the processes of drawing and relaxed heat set treatment are conducted continuously and the so-called SDTY method in which all the processes of spinning, drawing, and relaxed heat set treatment are conducted continuously can be followed. Any of these methods may be optionally adopted.

As explained in the above, the conjugate filamentary yarn of the present invention is a composite spun from a component of thermoplastic elastomer and a component of polyamide or polyester arranged in a specific relationship, whereby both the stretchability arising from crimp and rubber-like elasticity are

utilized to make an excellent crimped stretch conjugate yarn which shows high elastic recovery percentage of elongation and high degree of stretchability when highly elongated, which have never been seen with conventional stretch yarns. Therefore, it is very useful for the preparation of panty hose and other woven or knitted fabrics.

Incidentally, there occurs a reversal point r_P regarding the direction with a component P as shown in Fig. 3, (b), which the states of filament at a changing degree of stretch. However, this causes no trouble in actual use.

The present invention is described in detail by the following examples. The hardness of the elastomer component, elongation of crimp (EL), rubber-like elasticity (RE), total crimp (TC) shrinkage in boiling water treatment (FS), and elongation recovery (ER), used in the examples, were measured according to the following methods.

(1) Hardness:
According to JIS K-6301.

(2) Elongation of crimp (EL), rubber-like elasticity (RE):
A skein of a yarn, either drawn or relaxed by heat treatment after drawing, was weighted with an initial load of 2 mg/de, subjected to the crimping process in boiling water for 20 minutes, and dried naturally for 24 hours still under the initial load. The crimped yarn thus obtained was set on the tensile tester of Tensilon III type and the evaluation was made by inspecting the specimen with the use of a cathetometer of 20 magnifications. The test was started under the conditions: length of the specimen, 20 cm; initial load, 2 mg/de; elongation speed, 100%/min, and chart speed, 20 cm/min, with the cathetometer focused on the 10-cm middle part of the specimen. During the inspection, the state of the specimen shown in Fig. 3, (a), was observed at the initial stage, and the crimp was gradually stretched and soon reached the state as shown in Fig. 3, (b). A mark was put to indicate how far the specimen was elongated. The elongation obtained so far was the elongation arising from crimp. When further stretched, the specimen reached the state as shown in Fig. 3, (c). The stretch between Fig. 3, (b) and Fig. 3, (c), was rubber-like elasticity. The result of the determination was obtained from the average value of 5 measurements.

(3) Total crimp (TC) and shrinkage in boiling water treatment (FS):
A skein was prepared from a yarn which had been subjected to a relaxed heat set treatment and weighted with an initial load of 2 mg/de and the length (l_0) of the skein was measured. Without removing the initial load, the yarn was subjected to a crimping treatment for 20 minutes in boiling water and dried naturally for 24 hours under the load. The load was increased to a total of 200 mg/de and 1 minute later the length (l_1) of the skein was measured. Then the load was removed and the skein was weighted again with the initial load. 1 minute later the length (l_2) was measured. Total crimp (TC) and shrinkage in boiling water treatment (FS) were calculated by the following equations respectively.

$$\text{Total crimp (TC)}(\%)=\frac{l_1-l_2}{l_0}\times 100$$

$$\text{Shrinkage in boiling water treatment (FS)}\ (\%)=\frac{l_0-\bar{l}_1}{l_0}\times 100$$

(4) Elongation recovery (ER):
A skein was prepared from a yarn which had been subjected to a heat treatment, weighted with an initial load of 2 mg/de, subjected to a crimping process for 20 minutes in boiling water, and dried naturally for 24 hours without removing the initial load. The elongation recovery (ER) was determined with thus prepared specimen at a temperature of 20°±2°C and relative humidity of 65±2% by hanging the yarn as follows:
(a) Length of specimen yarn: 200 mm (length l_0 of yarn under initial load)
(b) Initial load: 2 mg/de
(c) Test load: 1000 mg/de
(d) Time under load: 3 minutes
(e) Measurement of yarn length l_1 under test load, removal of test load and weighting of yarn with initial load.
(f) Residual length l_2 of yarn was measured when 3 minutes had passed after initial load was replaced.
(g) Elongation recovery was calculated according to the following equation:

$$\text{Elongation recovery (ER)(\%)} = \frac{\text{Length of yarn recovered from elongation } (l_1 - l_2)}{\text{Length of yarn under load of 1000 mg/de after initial length } (l_1 - l_0)} \times 100$$

Example 1

Nylon 6 having an intrinsic viscosity [η] of 1.1 and a commercially available thermoplastic polyurethane Elastollan E595 (capro type) having a hardness of 95 (manufactured by Nippon Elastollan Co., Ltd.), which was to make the elastomer component, were melted separately at 247°C and 228°C and conjugate melt spun with the use of a spinneret of side-by-side type as shown in Fig. 5, (a), or spinneret of eccentric sheath-core type as described in the gazette of Japanese Patent Publication No. 27175/80, heated at 240°C. The area ratio EA/PA between the elastomer component and polyamide component on the cross section of the conjugate filament was varied by adjusting the extrusion ratio between the two component by means of the respective gear pumps. Also

$$\frac{b}{a}$$

and $\overline{EiPi}$ were varied by changing HE, HP, l and θ of the spinneret shown in Fig. 5, (a). The conjugate yarn was taken up as undrawn yarn at a take up speed of 500 m/min while applying 0.6% of silicone oil. After that, the yarn was drawn separately in a drawing process and given an elongation at break of 30% to 40%. The elongation of crimp (EL) and rubber-like elasticity of the drawn yarn were determined and the results are shown in Table 1, Nos. 2—9, No. 11 and Nos. 13—14.

The same determination was conducted with conjugate filament having the structure as shown in Fig. 2, (a), prepared by use of a spinneret of side-by-side type described in the gazette of Japanese Patent Publication No. 20247/68 and the result is also shown in Table 1, No. 1.

Furthermore, the result obtained with a conjugate filamentary yarn prepared from an elastomer component comprising commercially available Elastomer Diamide×3978 of polyamide type having a hardness of 97 manufactured by Daicel Chemical Industries Ltd. and the other component comprising polyethylene terephthalate, [η] 0.65, modified with 2.7 mole % of 5-sodium sulfoisophthalate under the conditions of Table 1, No. 3 is shown in No. 10 of the same table and another result obtained with a conjugate filamentary yarn prepared from an elastomer component comprising said Elastomer Diamide×3978 of polyamide type and the other component comprising polybutylene terephthalate, [η] 0.87, modified with 2.1 mole % of 5-sodium sulfoisophthalate under the conditions of Table 1, No. 3 is shown in No. 12.

TABLE 1

Run No.	Cross section of a filament	b/a	EA/PA	$\overline{EiPi}$	EL (%)	RE (%)
*1	Fig. 2, (a)	1	1	0.7a	69	4
*2	Fig. 1, (a)	1.1	1	0.7a	71	5
3	"	1.4	1	0.6a	73	28
4	"	3.8	1	1.6a	25	29
*5	"	4.2	1	2.1a	7	16
6	"	1.6	2.2	1.2a	83	46
7	"	1.5	0.45	1.3a	64	33
*8	"	1.4	0.40	1.1a	31	3
*9	"	1.3	1	0.4a	83	3
10	"	1.5	1	0.7a	65	24
*11	"	1.7	2.5	1.1a	49	7
12	"	1.5	1	0.7a	59	22
13	Fig. 1, (c)	1.4	1	0.6a	66	25
14	Fig. 1, (b)	1.5	1	0.6a	70	26

* Comparison.

The specimens which satisfied the conditions specified by the present invention had both elongation of crimp (EL) and rubber-like elasticity (RE) of 20% or more and showed excellent stretchability but those which did not satisfy the conditions specified by the present invention especially showed smaller rubber-like elasticity and failed to show powerful stretchability.

Example 2

Nylon 6 having an intrinsic viscosity [η] of 1.1 (determined by use of m-cresol solution at 30°C) and a polyurethane component comprising commercially available thermoplastic polyurethane Elastollan E595 (capro type) having a hardness of 95 and another polyurethane component comprising Elastollan E995 (carbonate type) having the hardness of 95 (both manufactured by Nippon Elastollan Co., Ltd.) were used to prepare respective conjugate filamentary yarns. Nylon 6 was melted at 247°C, polyurethane E595 at 228°C, and E995 at 230°C separately and were made into two kinds of conjugate filamentary yarns respectively with the use of a spinneret of side-by-side type heated at 245°C as shown in Fig. 5, (a). The area ratio EA/PA between the polyurethane component and the polyamide component was made 1 by adjusting the respective extrusion ratios between the components. The cross section of the respective filaments took the shape of Fig. 1, (a), and a/b was made 1.5 by adjusting l and θ of the spinneret of Fig. 5, (a). 0.6% by weight of silicone oil was applied to the obtained melt spun yarns and undrawn yarns of 700 denier/12 filaments were obtained.

The thus obtained undrawn yarn was once taken up and was then subjected to the DTY process, wherein drawing and relaxed heat set treatment were combined in a continuous process, or the yarn was, without being taken up, directly subjected to the SDTY process where spinning was followed by drawing and relaxed heat set treatment, to be put to the test. The drawing is so conducted as to give an elongation at break of 25 to 35% to the drawn yarn. After having been heat treated at various temperature, the yarn was led to the heated compressed air nozzle as described in Fig. 1 of the specification of U.S. Patent 4188691, wherein temperature of the compressed air and relaxation rate were varied while the pressure of the compressed air kept constant at 1.0 kg/cm^{2}G. In Table 2, the conditions of drawing and texturing, and the physical properties of the obtained crimped stretch yarns are shown.

The results of the tests conducted for the filaments prepared having the structure of Fig. 2, (a), by use of an ordinary spinneret of side-by-side type described in the gazette of Japanese Patent Publication No. 20247/68, are also shown in Table 2.

TABLE 2

	Spinning and drawing conditions						Texturing conditions		Properties of crimped yarns				
Run No.	Cross section of the filament	Kind of polyurethane	Texturing method	Spinning speed (m/min)	Drawing speed (m/min)	Heat treating temperature after drawing (°C)	Temperature of heated compressed air (°C)	Relaxation (%)	TC (%)	FS (%)	EL (%)	RE (%)	ER (%)
15	Fig. 1, (a)	E595	DTY	500	1000	Room temperature	80	30	40	19	118	52	86
16	"	E995	"	"	"	"	100	"	43	21	125	80	89
17	"	"	"	"	"	80	"	"	41	20	102	58	88
18	"	"	"	"	"	120	"	"	37	17	85	37	84
19	"	"	"	"	"	130	"	"	33	15	65	20	80
20	"	"	"	"	"	Room temperature	60	"	44	25	112	75	88
21	"	"	SDTY	"	2000	"	80	"	43	22	125	75	88
22	"	"	"	"	"	"	100	"	43	21	125	80	89
23	"	"	"	"	"	"	150	"	41	18	85	35	84
24	"	"	DTY	"	1000	"	160	"	39	16	70	20	79
25	"	"	"	"	"	"	100	5	34	19	74	24	80
26	"	"	"	"	"	"	"	10	36	20	90	40	83
27	"	"	"	"	"	"	"	20	40	21	106	60	86
*28	Fig. 2, (a)	"	"	"	"	"	"	30	37	18	125	6	67

" Comparison

As can be seen from Table 2, those specimens in Nos. 15 to 18, 21 to 23, 26 and 27, wherein the optimum conditions mentioned before were satisfied, showed elongation of crimp (EL) of 85 to 125% and rubber-like elasticity (RE) of 35 to 80%, making a considerable total of 120 to 200%. The elongation recovery (ER) under load of 1.0 g/de was more than 80%, showing excellent stretchability and recoverability to provide stretch yarns which would not raise any problem as to dimensional stability. In contrast to the preceding specimens, Nos. 19 and 24 where the temperature of post-drawing heat treatment was beyond the range of room temperature to 120°C or the temperature of heated compressed air was beyond the range of 80 to 150°C and No. 25 where the relaxation percentage was less than 10%, showed a good shrinkage in boiling water treatment (FS) but the elongation of crimp (EL) and rubber-like elasticity (RE) were both low and the elongation recovery (ER) was below 80%.

No. 20, in which the temperature of heated compressed air was low, showed good elongation of crimp (EL) and rubber-like elasticity (RE) but the obtained stretch yarn tended to show unsatisfactory dimensional stability because of its high shrinkage in boiling water treatment reading of 25%.

Further, conjugate stretch filament No. 28, which was prepared in a side-by-side arrangement whose cross section was formed as shown in Fig. 2, (a), failed to exhibit a satisfactory screw structure when it was stretched. The yarn accordingly had only a slight degree of rubber-like elasticity and did not have powerful stretchability.

Claims

1. A conjugate filamentary yarn in which each of the individual filaments comprises an elastomeric thermoplastic polymer component and a non-elastomeric polymer component in side-by-side or eccentric sheath-core relationship, characterised in that, the non-elastomeric thermoplastic polymer component is a polyamide or polyester, each of the individual filaments has an elongate cross-section, and the respective components are arranged in such a way as to satisfy formulae (I) to (III) simultaneously:

$$4 \geqq \frac{b}{a} \geqq 1.2 \qquad (I)$$

$$2.3 \geqq \frac{EA}{PA} \geqq 0.43 \qquad (II)$$

$$\overline{EiPi} \geqq \frac{a}{2} \qquad (III)$$

where a indicates the length of the minor axis which passes the centre of gravity on the cross section of the filament; b, the length of the major axis which passes the centre of gravity on the cross section of the filament; EA, the area occupied by elastomer on the cross section of the filament; PA, the area occupied by non-elastomeric polyamide or polyester on the cross section of the filament; and $\overline{EiPi}$, the distance between the centre of gravity Ei of the elastomer component on the cross section of the filament and the centre of gravity Pi of the non-elastomeric polyamide or polyester component respectively.

2. A conjugate filamentary yarn according to Claim 1, wherein the cross section of the filament is figure-8-shaped.

3. A conjugate filamentary yarn according to Claim 1, wherein the cross section of the filament is oval.

4. A conjugate filamentary yarn according to any one of Claims 1 to 3, wherein the centre of gravity of said thermoplastic elastomer (Ei) and the centre of gravity of said non-elastomeric polyamide or polyester (Pi) are located on the major axis which passes the centre of gravity i on the cross section of the filament.

5. A conjugate filamentary yarn according to any one of Claims 1 to 4, wherein said filament is prepared in a side-by-side arrangement.

6. A conjugate filamentary yarn according to any one of Claims 1 to 4, wherein said filament is prepared in an eccentric sheath-core arrangement.

7. A conjugate filamentary yarn according to any one of Claims 1 to 6, wherein the hardness of said thermoplastic elastomer (measured according to JIS K-6301) is within the range of 90 to 100.

8. A conjugate filamentary yarn according to any one of Claims 1 to 7, wherein said thermoplastic elastomer is elastomer of polyurethane type.

9. A conjugate filamentary yarn according to any one of Claims 1 to 7, wherein said thermoplastic elastomer is elastomer of polyamide type.

10. A conjugate filamentary yarn according to any one of Claims 1 to 9, wherein said non-elastomeric polyamide is nylon 6.

11. A conjugate filamentary yarn according to any one of Claims 1 to 9, wherein said non-elastomeric polyester is polyethylene terephthalate or polybutylene terephthalate.

12. A conjugate filamentary yarn according to Claim 11, wherein said non-elastomeric polyester is polyester which is copolymerized with 5-sodium sulfoisophthalic acid.

Patentansprüche

1. Filamentartiges Zweikomponentengarn, wobei jedes der einzelnen Filamente eine elastomere thermoplastische Polymerkomponente und eine nichtelastomere Polymerkomponente in Seite-an-Seite-Beziehung oder extentrischer Hülle-Kern-Beziehung aufweist, dadurch gekennzeichnet, daß die nichtelastische thermoplastische Polymerkomponente ein Polyamid oder Polyester ist, jedes der einzelnen Filamente einen gestreckten Querschnitt aufweist und die jeweiligen Komponenten in einer solchen Weise angeordnet sind, daß sie gleichzeitig den Formeln (I) bis (III) entsprechen

$$4 \geqq \frac{b}{a} \geqq 1.2 \qquad (I)$$

$$2.3 \geqq \frac{EA}{PA} \geqq 0.43 \qquad (II)$$

$$\overline{EiPi} \geqq \frac{a}{2} \qquad (III)$$

worin a die Länge der kleineren Achse angibt, welche durch den Schwerpunkt an dem Querschnitt des Filaments hindurchgeht, b die Länge der Hauptachse ist, die durch den Schwerpunkt an dem Querschnitt des Filaments hindurchgeht, EA die Fläche wiedergibt, die von dem Elastomeren an dem Querschnitt des Filaments eingenommen wird, PA die Fläche ist, die durch das nichtelastomere Polyamid oder den nichtelastomeren Polyester an dem Querschnitt des Filaments eingenommen wird, und $\overline{EiPi}$ der Abstand zwischen dem Schwerpunkt Ei der Elastomerkomponente an dem Querschnitt des Filaments und dem Schwerpunkt Pi an der nichtelastomeren Polyamid- bzw. Polyesterkomponente darstellt.

2. Filamentartiges Zweikomponentengarn nach Anspruch 1, dadurch gekennzeichnet, daß der Querschnitt des Filaments die Figur einer 8 besitzt.

3. Filamentartiges Zweikomponentengarn nach Anspruch 1, dadurch gekennzeichnet, daß der Querschnitt des Filaments oval ist.

4. Filamentartiges Zweikomponentengarn nach einem der Ansprüche 1 bis 3, dadurch gekennzeichnet, daß der Schwerpunkt des thermoplastischen Elastomeren Ei und der Schwerpunkt des nichtelastomeren Polyamids oder Polyester Pi an der Hauptachse liegen, die durch den Schwerpunkt an dem Querschnitt des Filaments hindurchgeht.

5. Filamentartiges Zweikomponentengarn nach einem der Ansprüche 1 bis 4, dadurch gekennzeichnet, daß das Filament in einer Seite-an-Seite-Anordnung hergestellt ist.

6. Filamentartiges Zweikomponentengarn nach einem der Ansprüche 1 bis 4, dadurch gekennzeichnet, daß das Filament in einer exzentrischen Hülle-Kern-Anordnung hergestellt ist.

7. Filamentartiges Zweikomponentengarn nach einem der Ansprüche 1 bis 6, dadurch gekennzeichnet, daß die Härte des thermoplastischen Elastomeren (gemessen gemäß JIS K-6301) innerhalb des Bereichs von 90 bis 100 liegt.

8. Filamentartiges Zweikomponentengarn nach einem der Ansprüche 1 bis 7, dadurch gekennzeichnet, daß das thermoplastische Elastomere ein Elastomeres des Polyurethantyps ist.

9. Filamentartiges Zweikomponentengarn nach einem der Ansprüche 1 bis 7, dadurch gekennzeichnet, daß das thermoplastische Elastomere ein Elastomeres des Polyamidtyps ist.

10. Filamentartiges Zweikomponentengarn nach einem der Ansprüche 1 bis 9, dadurch gekennzeichnet, daß das nichtelastomere Polyamid aus Nylon-6 besteht.

11. Filamentartiges Zweikomponentengarn nach einem der Ansprüche 1 bis 9, dadurch gekennzeichnet, daß der nichtelastomere Polyester aus Polyethylenterephthalat oder Polybutylenterephthalat besteht.

12. Filamentartiges Zweikomponentengarn nach Anspruch 11, dadurch gekennzeichnet, daß der nichtelastomere Polyester ein Polyester ist, der mit 5-Natriumsulfoisophthalsäure copolymerisiert worden ist.

Revendications

1. Fil filamenteux à deux constituants dans lequel chacun des filaments individuels comprend un constituant de polymère thermoplastique élastomère et un constituant de polymère non élastomère en relation de côte à côte ou relation excentrique de gaine à âme, caractérisé en ce que:

le constituant polymère thermoplastique non élastomère est un polyamide ou un polyester, chacun des filaments individuels a une section o-blongue, et
les constituants respectifs sont disposés de manière à satisfaire simultanément aux formules (I) à (III):

$$4 \geqq \frac{b}{a} \geqq 1.2 \qquad (I)$$

$$2.3 \geqq \frac{EA}{PA} \geqq 0.43 \qquad (II)$$

$$\overline{EiPi} \geqq \frac{a}{2} \qquad (III)$$

où a indique la longueur du petit axe qui passe par le centre de gravité sur la section du filament; b, la longueur du grand axe qui passe par le centre de gravité sur la section du filament; EA, l'aire occupée par l'élastomère sur la section du filament; PA, l'aire occupée par du polyamide ou du polyester non élastomère sur la section du filament; et $\overline{EiPi}$, la distance entre le centre de gravité Ei du constituant élastomère sur la section du filament et le centre de gravité Pi du constituant polyamide ou polyester non élastomère respectivement.

2. Fil filamenteux à deux constituants selon la revendication 1, dans lequel la section du filament est en huit de chiffre.

3. Fil filamenteux à deux constituants selon la revendication 1, dans lequel la section du filament est ovale.

4. Fil filamenteux à deux constituants selon l'une quelconque des revendications 1 à 3, dans lequel le centre de gravité dudit élastomère thermoplastique (Ei) et le centre de gravité dudit polyamide ou polyester non élastomère (Pi) sont situés sur le grand axe qui passe par le centre de gravité i sur la section du filament.

5. Fil filamenteux à deux constituants selon l'une quelconque des revendications 1 à 4, dans lequel ledit filament est préparé dans une disposition côte à côte.

6. Fil filamenteux à deux constituants selon l'une quelconque des revendications 1 à 4, dans lequel ledit filament est préparé dans une disposition gaine-âme excentrique.

7. Fil filamenteux à deux constituants selon l'une quelconque des revendications 1 à 6, dans lequel la dureté dudit élastomère thermoplastique (mesurée selon la norme industrielle japonaise K-6301) est comprise entre 90 et 100.

8. Fil filamenteux à deux constituants selon l'une quelconque des revendications 1 à 7, dans lequel ledit élastomère thermoplastique est de l'élastomère du type polyuréthanne.

9. Fil filamenteux à deux constituants selon l'une quelconque des revendications 1 à 7, dans lequel ledit élastomère thermoplastique est de l'élastomère du type polyamide.

10. Fil filamenteux à deux constituants selon l'une quelconque des revendications 1 à 9, dans lequel ledit polyamide non élastomère est du nylon 6.

11. Fil filamenteux à deux constituants selon l'une quelconque des revendications 1 à 9, dans lequel ledit polyester non élastomère est du téréphtalate de polyéthylène ou du téréphtalate de polybutylène.

12. Fil filamenteux à deux constituants selon la revendication 11, dans lequel ledit polyester non élastomère est du polyester copolymérisé avec de l'acide 5-sodium sulfoisophtalique.

FIG. 1

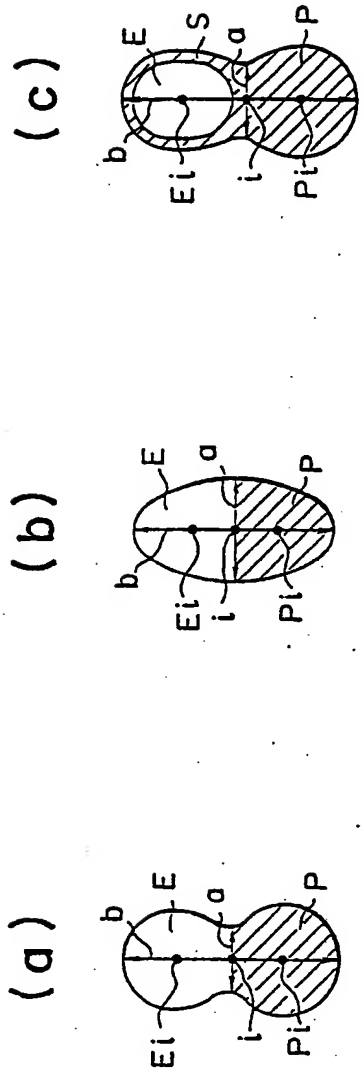
(a)
b
E
a
P
Ei
i
Pi
(b)
E
a
P
b
Ei
i
Pi
(c)
E
S
a
P
b
Ei
i
Pi

FIG. 2

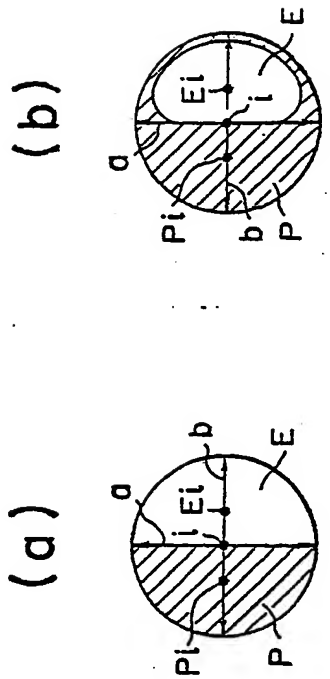
(a)
b
E
a
i
Ei
Pi
P
(b)
E
Ei
i
a
Pi
b
P

FIG.3

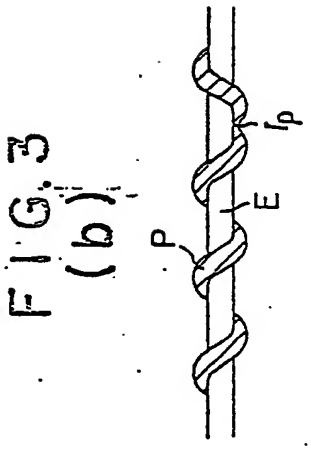

FIG.4

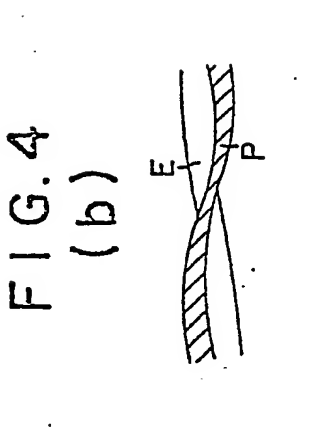

FIG.5